

# **The Central Role of Tether-Cutting Reconnection in the Production of CMEs**

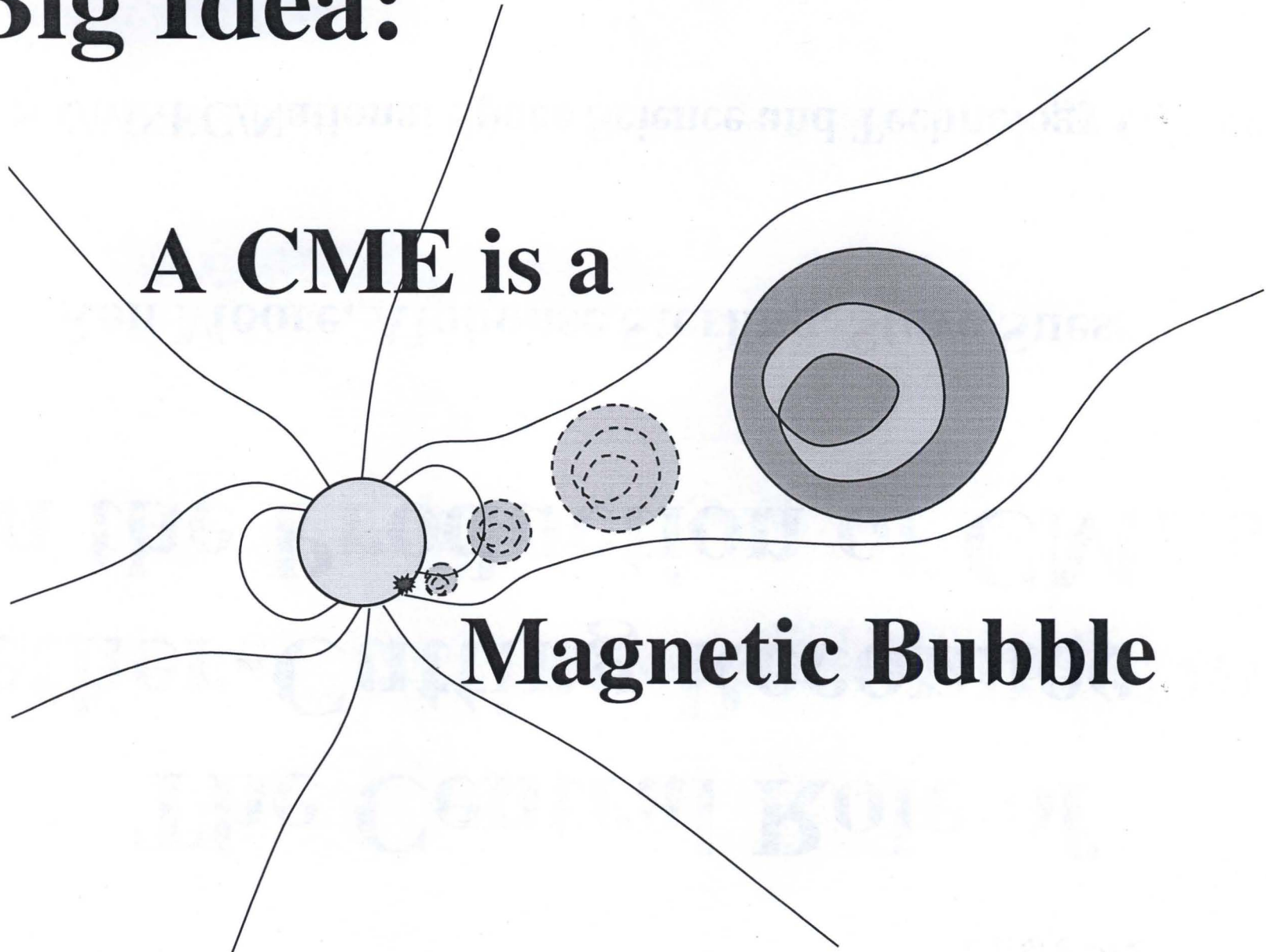
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# Big Idea:

**A CME is a**

**Magnetic Bubble**



# Main Points

- The standard scenario for CME production is basically the right picture.
- A CME is a magnetically inflated (low-beta) “plasmoid with legs.”
- Tether-cutting reconnection does most of the building and unleashing of the CME plasmoid.
- Tether-cutting reconnection is only one way to trigger a CME explosion.
- The CME propels itself by pushing on the surrounding coronal magnetic field.

# **Outline**

**I. Introduction**

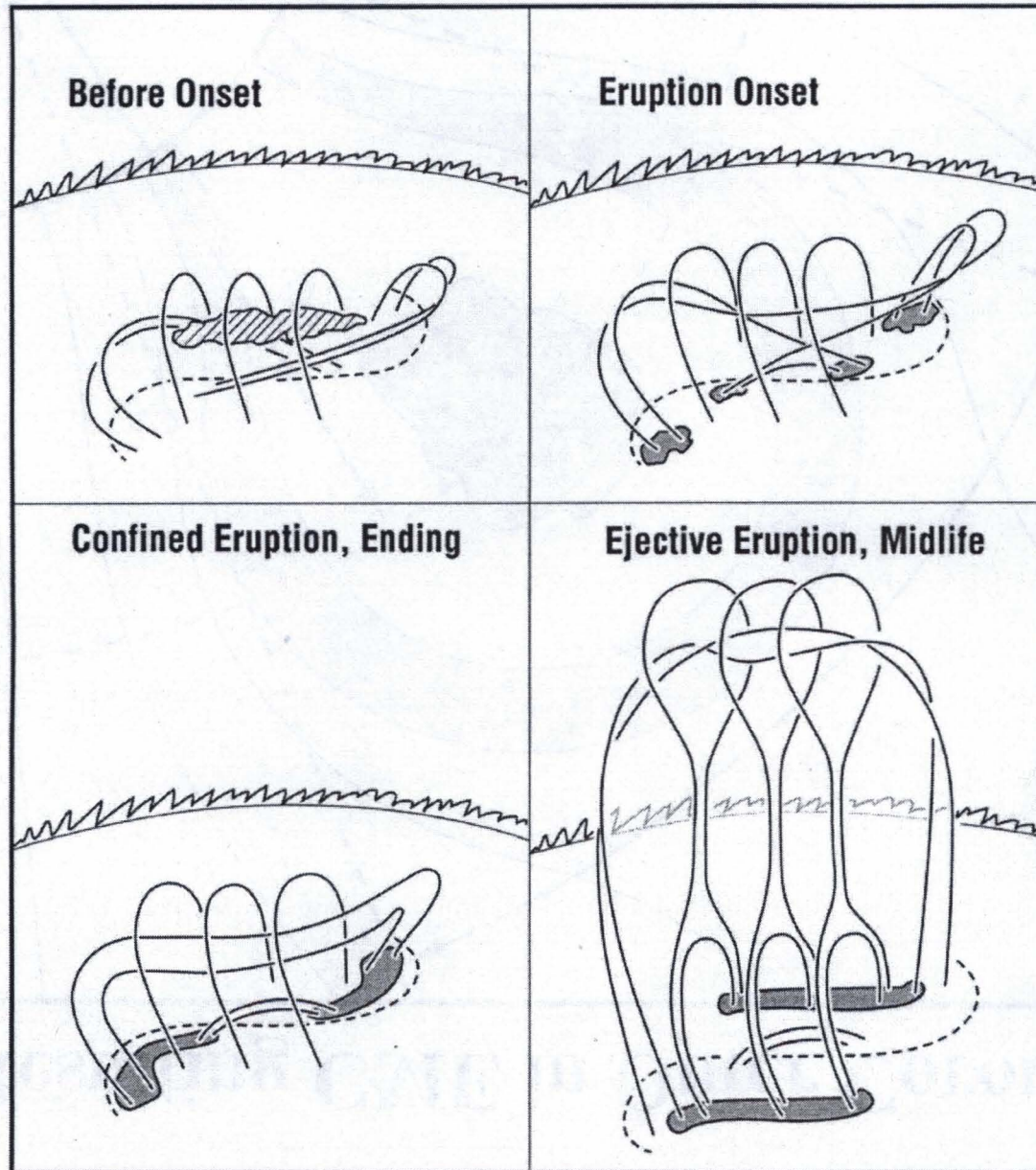
**II. Standard Scenario for CME Production**

**III. New Observational Test**

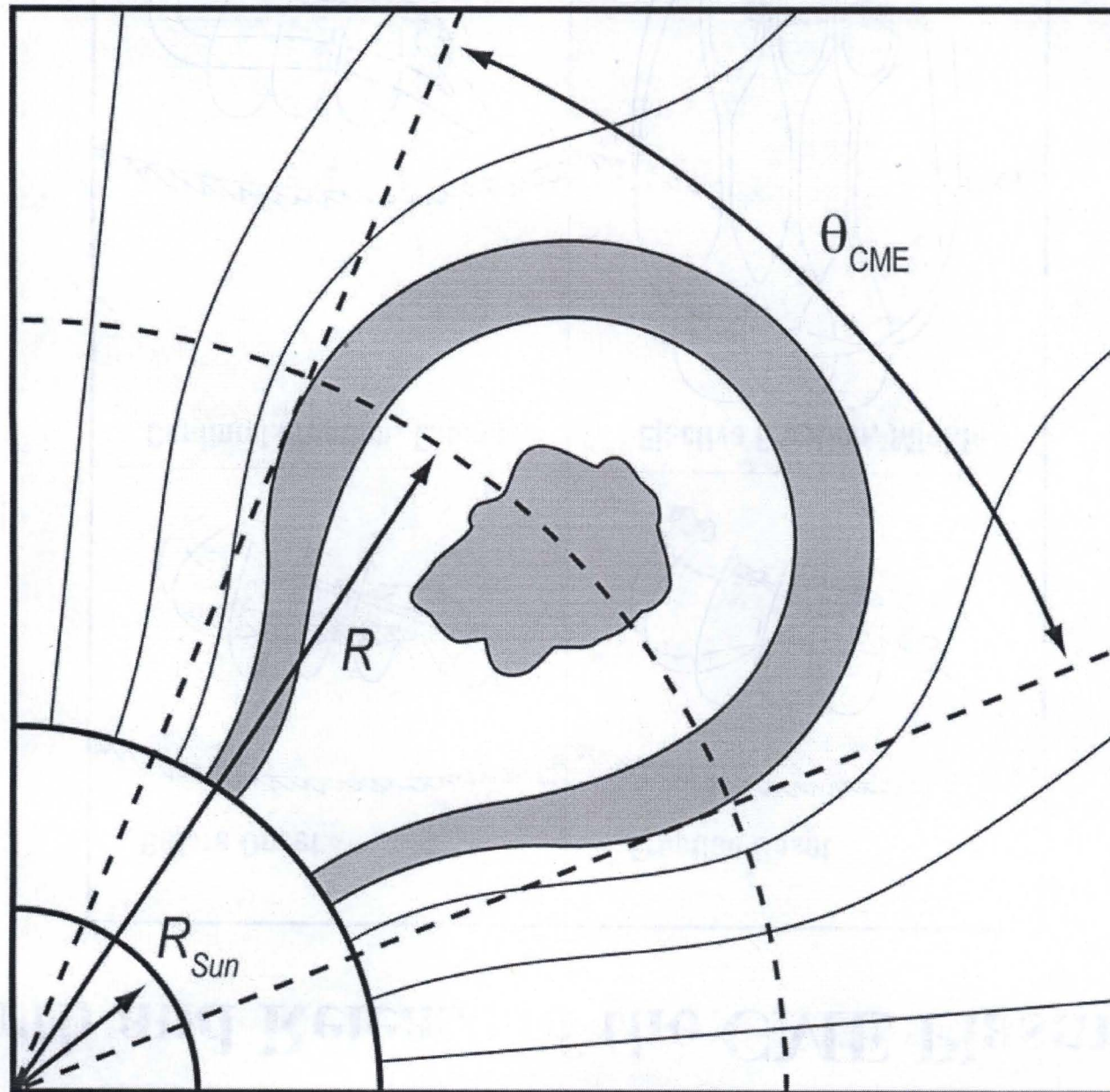
**IV. Conclusion**



# Birth and Release of the CME Plasmoid

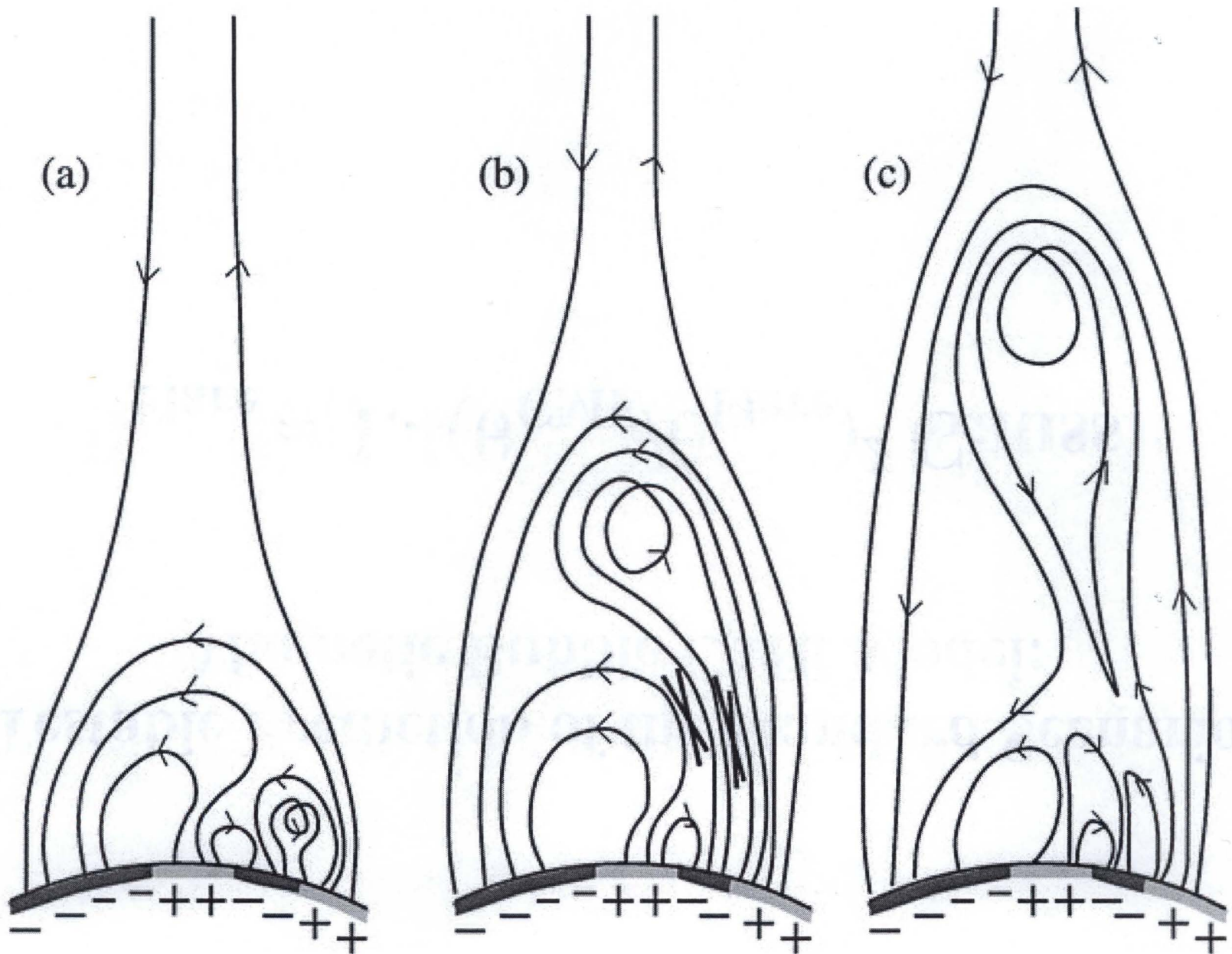


# Resulting CME in Outer Corona





# Governing Role of Surrounding Field

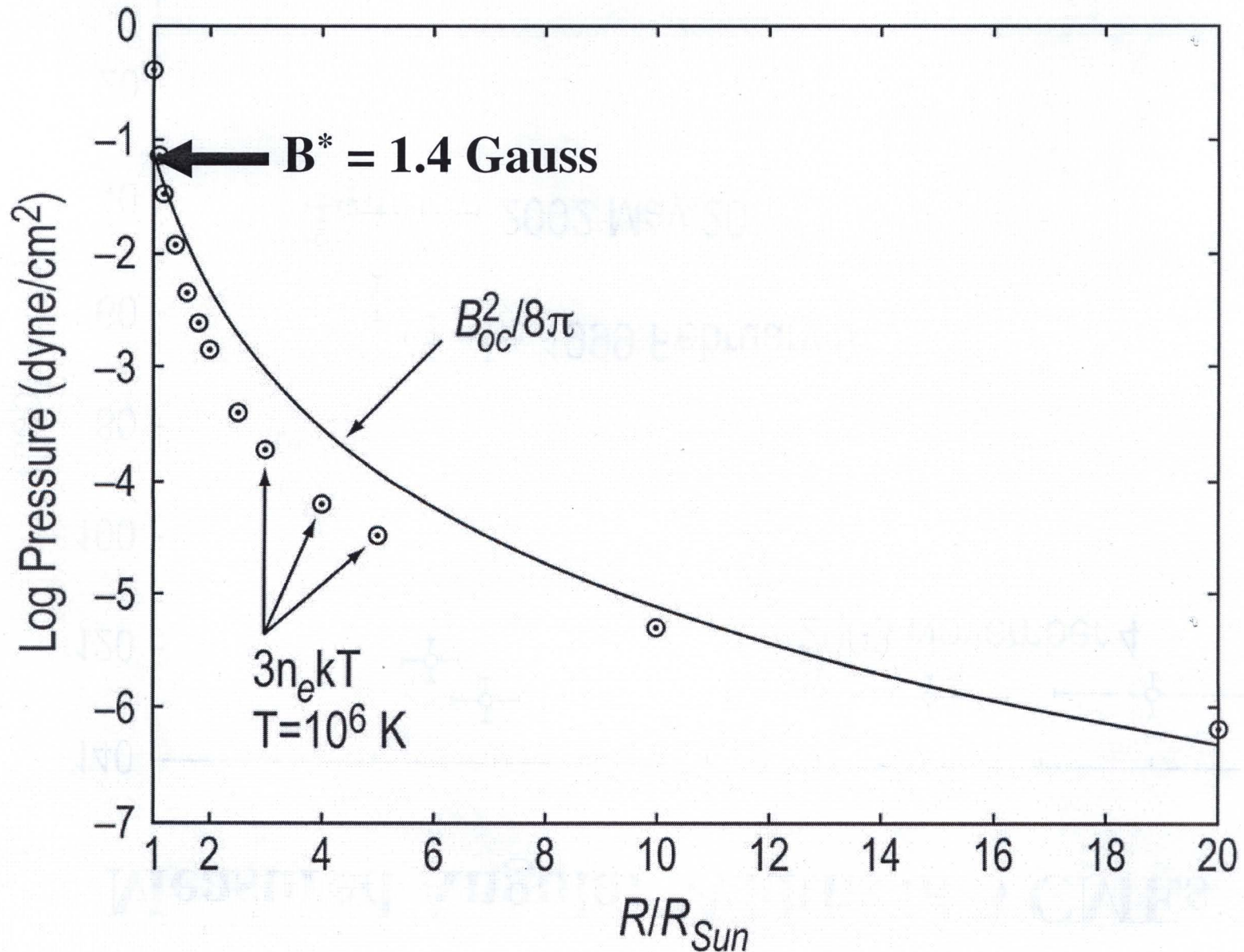


# **Testable Prediction of the Standard Scenario Magnetic Bubble CME Model:**

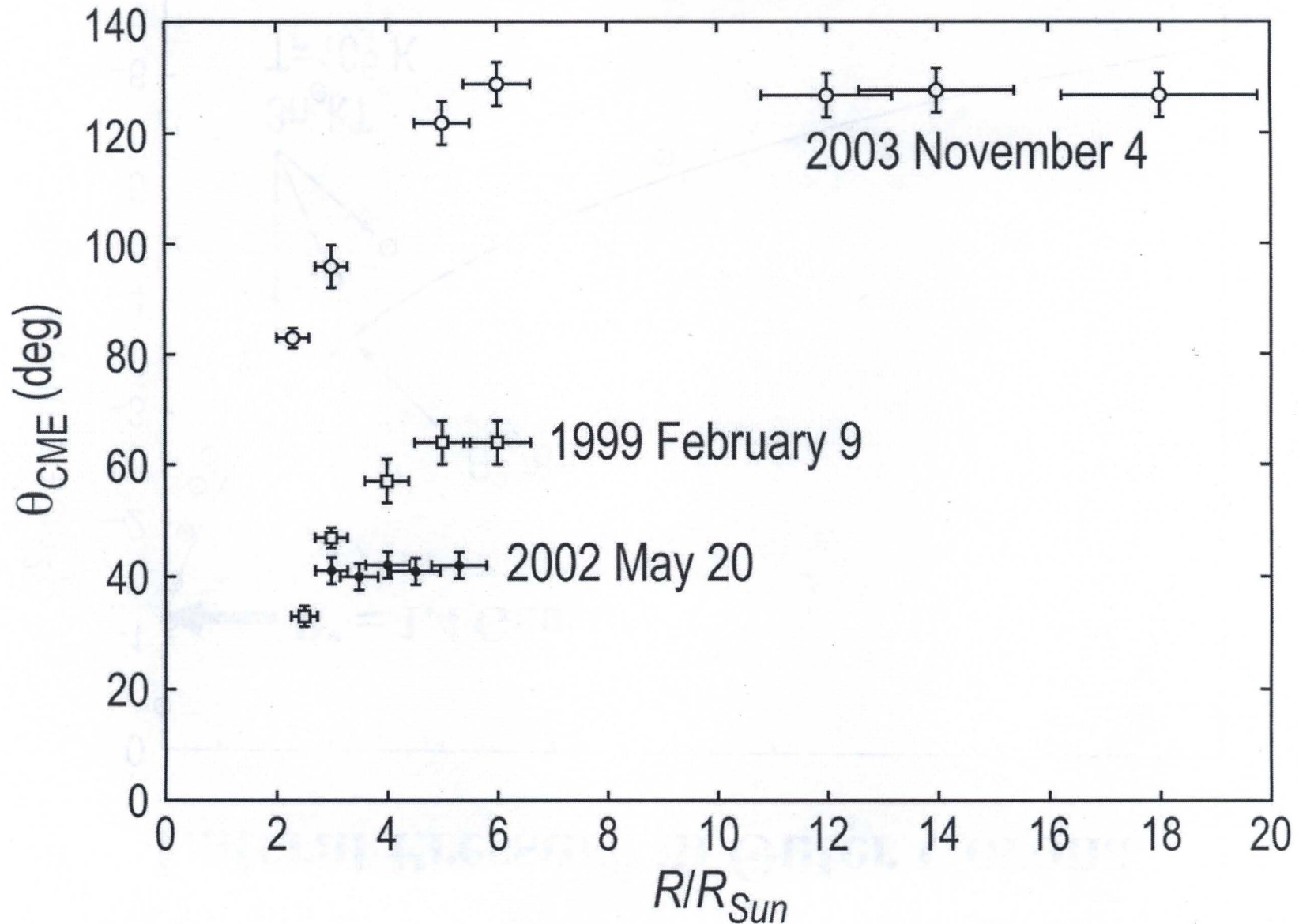
$$\mathbf{B_{Flare} \approx 1.4(\theta_{CME}/\theta_{Flare})^2 \text{ Gauss}}$$



# Lateral Pressure in Outer Corona



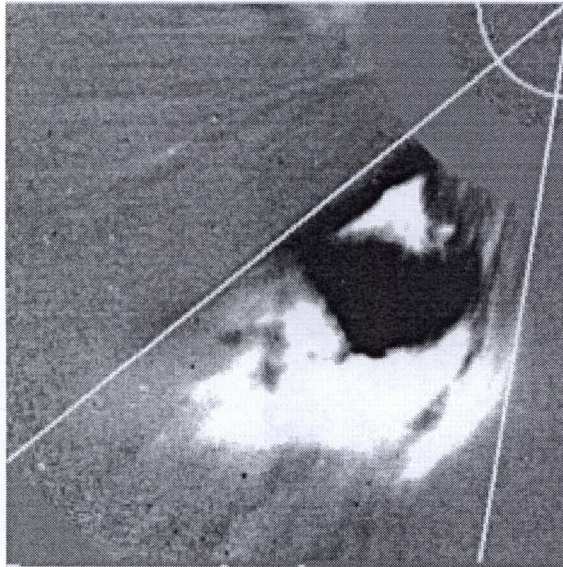
# Measured Angular Widths of 3 CMEs





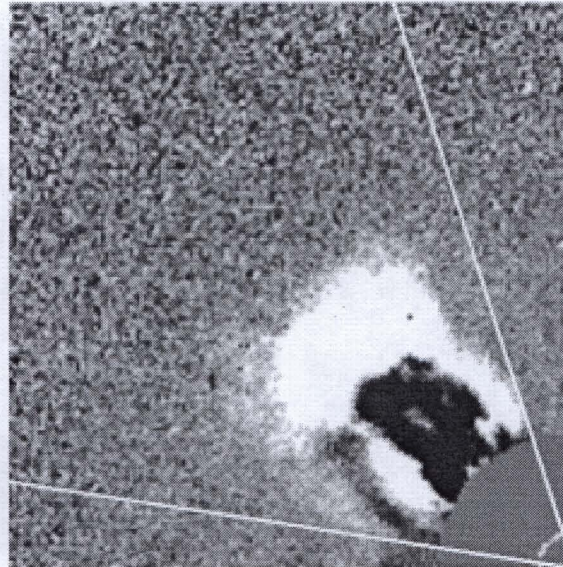
# LASCO Image of each CME at Final Width

**2002 May 20**



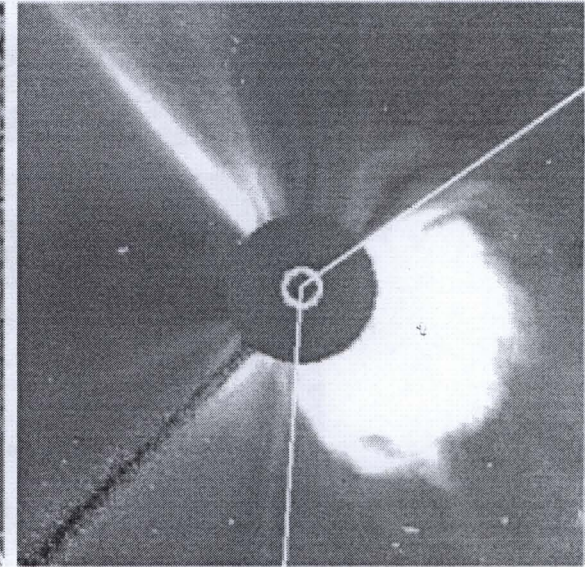
**C2 Difference Image**

**1999 Feb 9**



**C3 Difference Image**

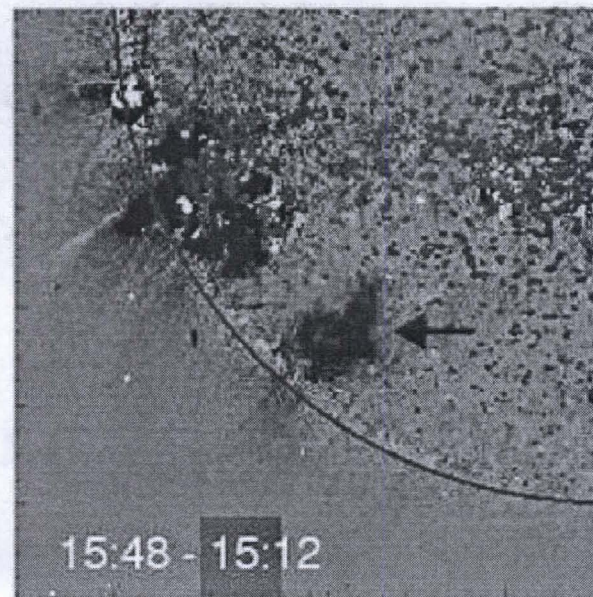
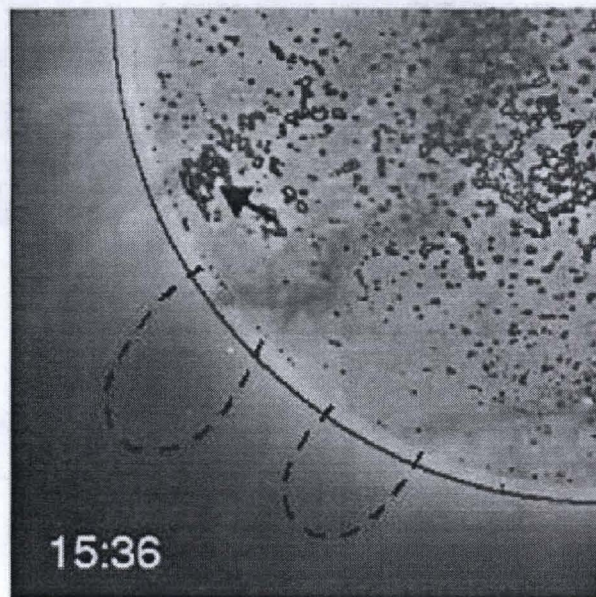
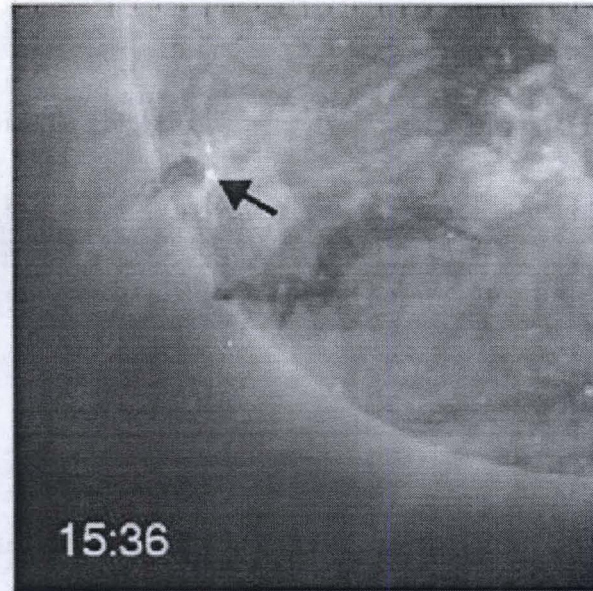
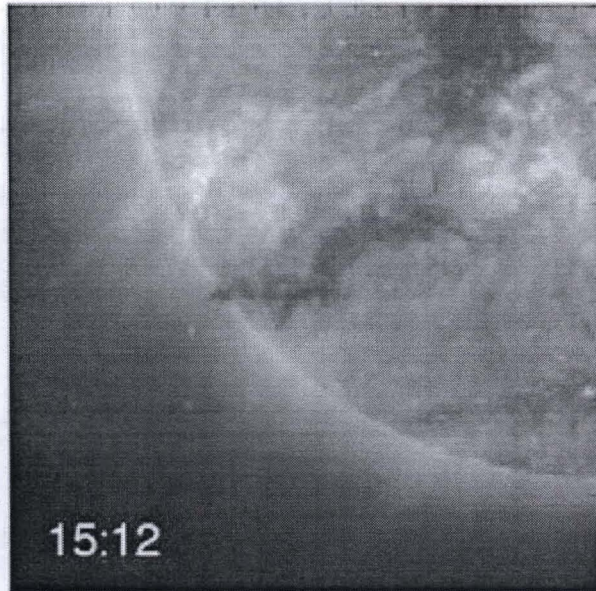
**2003 Nov 4**



**C3 Normal Image**



# Source of the CME of 2002 May 20





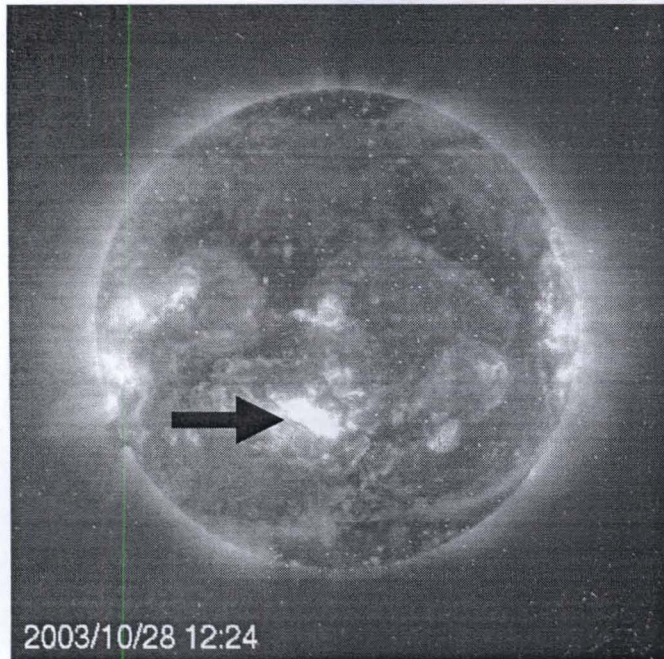
# Source of the CME of 1999 Feb 9





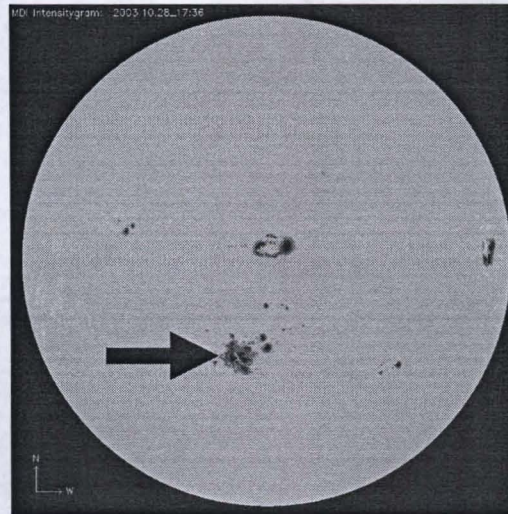
# Source of the CME of 2003 Nov 4

**Oct 28 X17 Flare Arcade**



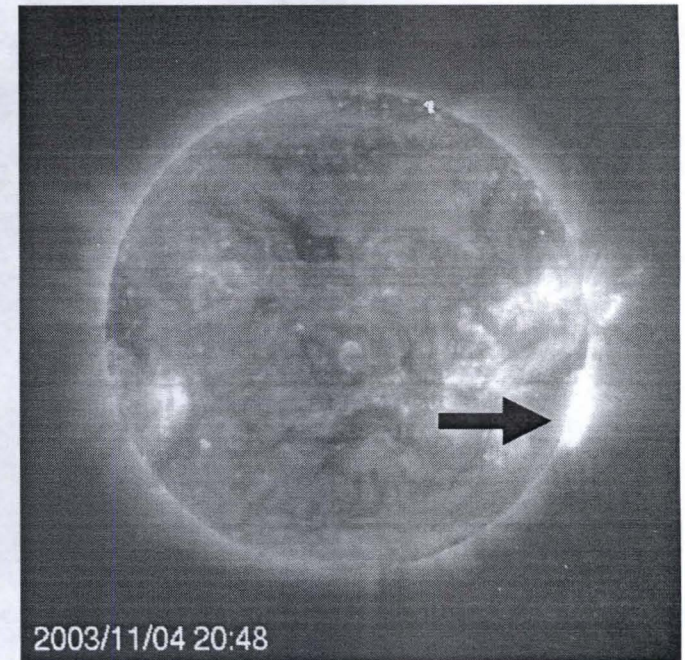
**EIT 195 Å Corona**

**Giant  $\delta$  Sunspot Centered Under Flare Arcade**



**MDI Photosphere**

**Nov 4 X20 Flare Arcade**



**EIT 195 Å Corona**



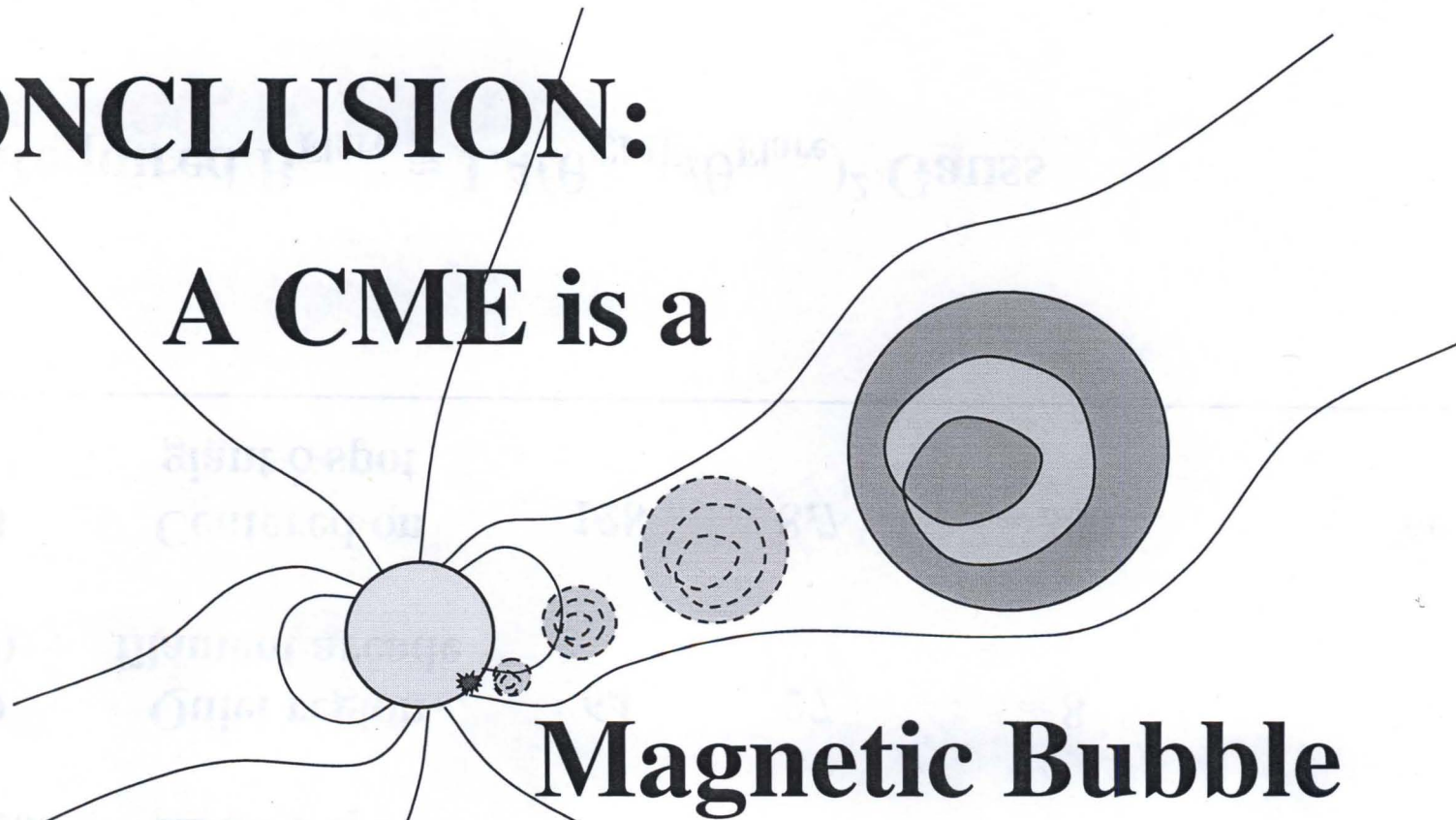
# Test Results

CME (date)	Source Region	$\theta_{\text{CME}}$ (deg)	$\theta_{\text{Flare}}$ (deg)	Required* $B_{\text{Flare}}$ (Gauss)	Required $B_{\text{Flare}}$ Fits Source Region? (Yes/No)
2002 May 20	Centered on small $\delta$ spot	41	2.2	$\approx 490$	Yes
1999 Feb 9	Quiet region filament arcade	64	27	$\approx 8$	Yes
2003 Nov 4	Centered on giant $\delta$ spot	128	8.7	$\approx 300$	Yes

\* Required  $B_{\text{Flare}} \approx 1.4(\theta_{\text{CME}}/\theta_{\text{Flare}})^2$  Gauss

# CONCLUSION:

**A CME is a**



**Magnetic Bubble**

- **Low-beta plasmoid**
- **Built and unleashed by tether-cutting reconnection**
- **Propelled by own magnetic field pushing on surroundings**